Heap, David Porter

History of the application of the electric light...

Washington

1883

97-84241-5
MASTER NEGATIVE #

COLUMBIA UNIVERSITY LIBRARIES
PRESERVATION DIVISION

BIBLIOGRAPHIC MICROFORM TARGET

ORIGINAL MATERIAL AS FILMED - EXISTING BIBLIOGRAPHIC RECORD

308
Z
Box 870
U. S. Light-house Board.
History of the application of the electric light to lighting the coasts of France, by Major D. P. Heap. Washington, Govt. Print. Off., 1883.
31 p. map, diagrs.

Treasury Department. Document no. 447. Light-house Board.
"Mainly reprinted from 'Science'."

TECHNICAL MICROFORM DATA

FILM SIZE: 35mm REDUCTION RATIO: 10:1 IMAGE PLACEMENT: IA IIA IB IIB

DATE FILMED: 11-11-97 INITIALS: JP

TRACKING # : 29149

FILMED BY PRESERVATION RESOURCES, BETHLEHEM, PA.

BIBLIOGRAPHIC IRREGULARITIES

MAIN ENTRY: Heap, David Porter

History of the application of the electric light to lighting the coasts of France

Bibliographic Irregularities in the Original Document:

List all volumes and pages affected; include name of institution if filming borrowed text.

_____ Page(s) missing/not available: ______________________

_____ Volume(s) missing/not available: ______________________

_____ Illegible and/or damaged page(s): ______________________

_____ Page(s) or volume(s) misnumbered: ______________________

_____ Bound out of sequence: ______________________

_____ Page(s) or volume(s) filmed from copy borrowed from: ______________________

_____ Other: ______________________

X Inserted material: unnumbered map inserted between pages 8 - 9

TRACKING#: MSH29149

HISTORY

OF THE

APPLICATION OF THE ELECTRIC LIGHT

TO

LIGHTING THE COASTS OF FRANCE.

BY

MAJOR D. P. HEAP,
Corps of Engineers, U. S. A., Engineer Secretary of the Light-House Board.

[MAINLY REPRINTED FROM "SCIENCE."]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1883.

HISTORY

OF THE

APPLICATION OF THE ELECTRIC LIGHT

TO

LIGHTING THE COASTS OF FRANCE.

BY

MAJOR D. P. HEAP,
Corps of Engineers, U. S. A., Engineer Secretary of the Light-House Board.

[MAINLY REPRINTED FROM "SCIENCE."]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1883.

TREASURY DEPARTMENT,
Document No. 447.
Light-House Board.

HISTORY

OF THE

APPLICATION OF THE ELECTRIC LIGHT TO LIGHTING THE COASTS OF FRANCE.

The value to navigation of thoroughly lighting our coasts is too evident to require any argument in its favor; and, in view of the immense interests at stake, there is no question but that improved methods of lighting should be adopted, almost regardless of expense, providing that the advantages gained are in any way commensurate with the cost.

France has long appreciated this; and it is to her that the world owes the Fresnel lens and many improved lamps burning successively whale, vegetable, and mineral oils. She has finally led the way, as usual, in the use of the electric light, which has been definitely adopted for the lighting of her coasts, after many expensive and conclusive experiments; and, when the plan has been fully carried out, France can boast of having the best and most systematic method of coast-lighting of any country in the world.

The United States has followed France. Our optical apparatus has been almost exclusively imported from that country. We use lamps made after French patterns, and now are about to make experiments to determine the value of the electric light for use in our light houses. This is deemed sufficient excuse for giving full details of the French system. The information has naturally been mostly obtained from French sources.

It was in 1863 that the electric light was for the first time used in light-houses. The experiment was made with an Alliance machine in the first-order light-house of La Hève, near Havre; and the results were so satisfactory that doubtless all the light-houses would have been immediately furnished with electric lights, had it not been for the great expense attending a general alteration. It was proved that the electric light was seen about eight kilometres farther than the oil light, and that in time of fog the range of the former light was more than double that of the latter.

M. Quinette de Rochemont, ingénieur des ponts et chaussées, published in 1870 a report upon the light-houses at La Hève. Below are some extracts:

"The electric light having been installed for six years at La Hève, enough time has elapsed to allow us to form an exact idea of the value of this means of producing light for the lighting of coasts. Sailors take pleasure in recognizing the good services rendered them by the electric light. The advantages of the system have been highly appreciated; the increase of the range of the light is very apparent; and, above all, in slightly foggy weather, many ships can continue their voyage, and enter the port at night, which they could not do when oil was used. The light, which at first was rather unsteady, gradually acquired a remarkable fixity, thanks to the improvement of the apparatus and to the experience gained by the keepers. The fears which were at first entertained regarding the delicacy of certain parts of the apparatus are not realized in practice. The accidents have been rare, the extinctions short and very few, two only during this period of six years having had a notable duration; one, of an hour, was due to an accident to the steam-engine; the other, of four hours, should, it appears, be attributed to malevolence. Under these circumstances it seems hardly worth while to worry about possible accidents."

Since 1863 experience has only confirmed the favorable views of M. Quinette. The light-houses of Gris-Nez, France; Cape Lizard, England; Odessa, Russia; and Port Said, Egypt, have been provided with electric apparatus; and there is a question of placing it in the light-houses of Planier and Palmyre, France, and in several light-houses in other foreign countries.

The following information was furnished by MM. Sautter and Lemonnier:

"When the light is to be fixed, the optical part of the apparatus is composed of a lenticular drum of proper form, which renders the rays horizontal in the vertical plane while allowing them to diverge in the horizontal plane. The dimensions of this drum vary from a diameter of half a metre for a fourth-order light to one metre in a first-order light. This increase in diameter of the apparatus is sensibly proportional to the increase in diameter of the carbon pencils between which the voltaic arc is produced, and which determines very nearly the dimensions of the electric light. It follows from this that the vertical divergence remains the same in the different types of apparatus. When the light is to be revolving, the fixed lens is surrounded by a movable drum formed of straight vertical lenses of which the form varies according to the characteristics desired to be given to the light."

Revolving electric lights have this great advantage over revolving oil lights: the flashes can be given a duration equal to that of the eclipses. In oil lights, when the light is concentrated in the form of flashes, there are two ends in view: First, to augment the intensity,

and consequently the range of the light; second, to create an appearance different from that of a fixed light. The first can only be obtained by giving the flash a duration much shorter than that of the eclipse; or, in other terms, by making the angle of the luminous beam a small part of the angle subtended by the lens. Moreover, this angle depends on the dimensions of the *foyer*,* and it can only be augmented either by increasing this dimension or by changing the focal distance of the lens, thus losing a part of the light, since the divergence is produced not only in the horizontal plane, the only one in which it is utilized for prolonging the flashes, but in every direction. With the combination of vertical lenses and a cylindrical drum which serves to produce flashes when electricity is used, the divergence of the beams can, by giving the vertical lenses a proper curvature, be augmented as much as desired in the horizontal plane, and the duration of the eclipses be diminished in proportion, while the range of the smallest electric light used will nevertheless remain much greater than that of the most powerful oil light.

For example: The luminous intensity of an annular panel of 45° of a first-order revolving light with a six-wick lamp equals 9,847 carcels. This is the greatest intensity obtained with an oil lamp. The divergence of the beam given by this same panel is 7° 7′, and the duration of the flash is about one-sixth part of the eclipse which precedes and follows it.

By applying the methods of M. Allard to the photometric measurements of electric lights, it is found that the luminous intensity of a fourth-order electric light, with a lens half a metre in diameter, and fed by a small-model Gramme machine, equals at least 20,000 carcels; and when concentrated by means of straight movable lenses in beams having a divergence such that the durations of the eclipses and flashes shall be the same, its intensity will be equal to 40,000 carcels; that is to say, that it will be four times more intense than that of the most powerful oil lamp, and with a much shorter duration of eclipse.

By means of electricity such immense quantities of light are produced that it is not necessary to take into account more or less beams in order to augment the range, the only object of the movable lenses being to produce characteristic appearances which distinguish clearly each light-house from its neighbor. These characteristic appearances,

* The French word *foyer* means literally a *hearth, a place where something is burnt*, and, in the sense used here, *the source of light and heat*, the *space occupied by the flame of a lamp or by the electric arc.* The word is so useful that I take the liberty of using it in place of an English paraphrase.

the method for producing them, and the system now adopted in France, will be mentioned farther on.

The different lights which serve for the lighting of French coasts are designed so as to answer the different needs of navigation; and their importance varies in consequence according to the rôle they are called upon to play, of which the most important is that of signalling to navigators their approach to land; and the lights constructed for this end are placed in preference upon more or less advanced headlands; which form, according to the expression of M. L. Reynaud, "the angles of a polygon circumscribing all dangers." These are the lights which should have the greatest luminous power, and which, therefore, constitute *first-order lights*.

Between these extreme points indicating the general contour of the coast, the latter still presents advanced points which should become centres of lights of less importance, and serve to guide the vessels to their harbors. The secondary lights placed on these points are called *second-order lights*, and merit their name, not only by their position, but also on account of the less power given to their optical apparatus. Along the route thus traced for navigation are also found localities which it is important should be pointed out to sailors; these are, for example, sand-banks, sunken rocks, islets, &c. From these arises the necessity of luminous *foyers* of various intensities, and the creation of *third*, *fourth*, and *fifth order*, and of even less powerful, *lights*, such as are placed in harbors on the end of jetties, to show vessels the entrance to the channel.

In addition, among all the lights of different orders, some, placed on an island, are designed to throw their light entirely around them; others, built on an advanced promontory or established on a straight part of the coast, only send their rays on a fraction, more or less great, of the zone which surrounds them; finally, others only have to light a determined point; hence the distinction of lights in *lights of all the horizon, of three-fourths the horizon, of two-thirds the horizon*, &c.

Until 1863 all the lights of the French coasts were furnished with apparatus for oil; and it was not until this epoch that there was installed, at one of the two lights of La Hève, the first apparatus for lighting by electricity. After a year and a half of experiment, the result having been most satisfactory, it was decided to light in the same way the second light of La Hève; and, about two years later, the electric light was also placed in the light-house at Cape Gris-Nez. Matters remained in this condition until within the last few years; and, while England counted on her coast six electric lights, the three which

we have just mentioned were the only ones in existence in France. Lately, the reconstruction of the light-house of Planier having been adjudged necessary, it was decided to use the electric light in it; and the same decision was taken regarding the light-house of La Palmyre, whose luminous intensity was recognized as insufficient.

But the good results given by the electric light at La Hève and at Cape Gris-Nez called attention to the more general service it could render; and on the 27th January, 1880, after a long study of the question, M. Allard, director of the French light-house department, presented to the minister of public works an important report, recommending the general adoption, upon the whole extent of the French coasts, of electric lighting. This report was approved on the 4th December, 1880, by the Conseil-Général des Ponts et Chaussées; and the principle of electric lighting has just been adopted for the entire extent of the coast. This decision was so important that it seems proper to mention here the principal points of M. Allard's report, to make known the arguments brought to the support of using the electric light, and the results obtained in various trials, and, finally, to give details of the electric installations of this nature actually in use.

Before mentioning the considerations in favor of changing oil for electricity, we must speak a few words on the range of light-houses. The *range* is the distance to which the light is visible at sea; the *circle* of range has this distance as a radius, and the light as a centre. The range of a light depends not only upon the optical conditions in which the light is placed, but also upon its height above the level of the sea. Thus there is a distinction between the *geographical range* and the *luminous range;* the latter being the one under consideration. It increases with the transparency of the atmosphere, which is very variable, and changes with the locality; thus, on an average, it is much greater on the Mediterranean than on the southwestern coasts of France, greater on the latter than on the shores of Brittany, and becomes the least in the British channel. Moreover, the transparency varies according to the seasons; and there are, during the year, a certain number of more or less foggy days, during which the transparency of the air and the range of the light are both diminished. It is impossible, therefore, to fix the range as a certain quantity; and it is necessary to establish a mode of designating the varying range. To do this, observations are made during the year on the variations of the range; the foggiest nights are then omitted, and the minimum range for the remainder of the year represents the range for that portion of the year. If, for example, thirty nights, or one-twelfth of the

year, are deducted, and, during the remainder of the year, the smallest range is twelve nautical miles, it is considered that the light under consideration has a range of twelve miles for eleven-twelfths of the year. In short, the range of a light during a portion of a year is the distance at which it is always visible during that portion.

In order that the lighting of coasts be efficient, it should be continuous, so that a vessel sailing along the coast, as soon as it passes the range of one light, should come within that of the next; in other words, the *circles* of range should cut each other successively. With the system of oil lights now in use, this is actually the case, but only during half the year; during the other half the oil lamps have not sufficient power. It will be very different when the electric light is used. The ranges will be increased, and the circles of ranges will cut each other during eleven-twelfths of the year.

The accompanying outline map, Fig. 1, shows what would be the ranges if the electric lights were used, supposing that each light had a mean intensity of 125,000 carcels. The dotted lines show the present ranges with oil lamps. When the electric light is adopted, the range of the new lights will be 27.7 nautical miles in the Mediterranean for fourteen-fifteenths of the year, 19 to 21 miles in the British channel for ten-twelfths of the year, and 22 to 26.5 miles on the Atlantic coast for the same period.

If the increase in the range, by using the electric light, is a powerful consideration in favor of this system, objections may, however, be made on the score of economy. The report of M. Allard shows that the expense of executing the entire programme, even including the installations of steam-sirens, will not exceed $1,600,000, which is very reasonable compared with the results obtained. Besides, the cost of maintenance of electric lights is not, as one might have supposed, much greater than that for oil lights. Thus the annual expense of a first-order oil light is about $1,660 per year, while for each electric light-house at La Hève the cost is $2,270, and for that of Cape Gris-Nez $2,680. If it is desired to compare the cost of a unit of light for a light-house lit by oil with one lit by electricity, it is found that the former costs $81 per unit, while the latter is $22 at Cape Gris Nez, and $19.40 at La Hève.

It should be said here that there is only taken account of, in the above figures, the light of the *foyer* itself, independently of the optical apparatus, which, by concentrating the rays, augments the intensity very considerably.

The number of electric lights comprised in the project is forty-six, counting as two the double lights of La Hève, of La Canche, and of

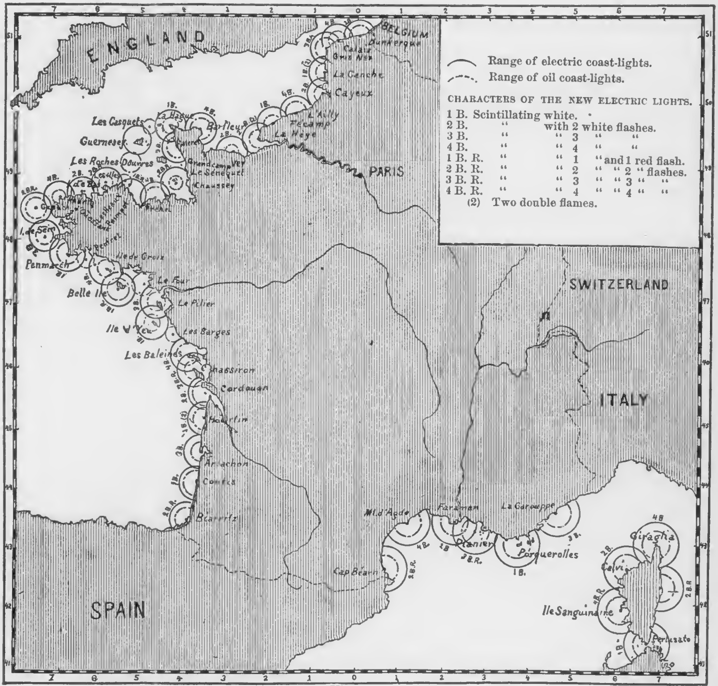
ENGLAND
BELGIUM
Dunkerque
Calais
Gris Nez
La Canche
Cayeux
L'Ailly
Fecamp
La Heve
Les Casquets
La Hague
Barfleur
Guernesey
Les Roches Douvres
Grandcamp
Ver
Le Senequet
Chaussey
PARIS
Ile de Sein
Penmarch
Ile de Groix
Le Four
Belle Ile
Le Pilier
Ile d'Yeu
Les Barges
Les Baleines
Chassiron
Cordouan
Hourtin
Arcachon
Contis
Biarritz
SPAIN
SWITZERLAND
ITALY
Mt d'Agde
Faraman
La Garoupe
Planier
Porquerolles
Cap Bearn
Giraglia
Calvi
Ile Sanguinaire
Pertusato
Range of electric coast-lights.
Range of oil coast-lights.
CHARACTERS OF THE NEW ELECTRIC LIGHTS.
1 B. Scintillating white.
2 B. " with 2 white flashes.
3 B. " " 3 " "
4 B. " " 4 " "
1 B. R. " " 1 " and 1 red flash.
2 B. R. " " 2 " " 2 " flashes.
3 B. R. " " 3 " " 3 " "
4 B. R. " " 4 " " 4 " "
(2) Two double flames.

Fig. 1.

Hourtin. Of this number there are thirty-eight of the first order, two of the second order, five of the third order, and a new one to be placed at the south of Paimpol. Four of these lights are already, or are about to be, lighted electrically.

As to the distribution of the lights, it is easy to follow it upon the map, (Fig. 1.) Almost everywhere the circles of ranges cut each other, and where there is a gap it will be filled with an oil light. This map also gives the distinctive characteristics of the different lights, and this is a most important point to be considered.

In a good system of coast-lights, the neighboring lights should have very distinctive characteristics, in order to avoid all possible confusion. In the existing system, these conditions obtain, and the first idea which naturally presented itself was to retain the old characteristics, simply substituting the electric for the oil light, so that there would be no change from that to which sailors were accustomed; but the existing characteristics are, in some ways, inconvenient, and it has been decided to replace them by others, which, by making the lights more easy to be distinguished, will, besides, increase the range.

The present characteristics are as follows:

1. A single fixed light.
2. A double fixed light.
3. An eclipsed light, with flashes every half minute.
4. An eclipsed light, with flashes every minute.
5. A fixed light varied by flashes every four minutes.
6. A fixed light varied by red flashes every four minutes.
7. A light with alternate red and white flashes.

Fixed lights are obtained with a Fresnel apparatus with cylindrical lenses; the double fixed light, by two lights situated at such a distance that they can easily be distinguished from each other, but still appear to form a pair. Fixed lights will eventually disappear, because they have a less range than flashing lights, and also are liable to be confounded with other fixed lights not belonging to a system of coast-lighting.

Flashing lights are obtained by means of optical apparatus having generally eight faces. Each face comprises, first, a lens of the same width as the face, then, above and below, portions of rings having as a common centre the centre of the lens. The apparatus thus gives rise to eight beams of light, separated by dark intervals, and when it is turned the navigator sees alternately a flash and an eclipse. The intervals between the flashes depend upon the rapidity of rotation.

This light has the inconvenience of requiring sustained attention, and the consulting of a time-piece to tell the length of the interval. It should be suppressed.

The fixed lights varied by flashes are obtained by means of an apparatus for a fixed light around which turn two or three vertical lenses which give flashes, either white or red, or alternately white or red at intervals of some minutes. These slowly revolving lights have the same fault as the preceding, and will also eventually disappear.

The characteristic which will be generally adopted is that of a *scintillating* light. To produce it, a fixed-light apparatus is employed, around which revolves a drum of lenses, placed vertically, composed of straight glass bars of lenticular cross-section; each of these concentrates the horizontal rays, and consequently produces a flash. During a rotation, if all the lenses are alike, the navigator will see a series of equal white flashes, producing a scintillating light. If the vertical lenses are alternately red and white, there will be alternately a red and a white flash, and a compound red-and-white scintillating light will result. In the same way, by placing the lenses in groups, there can be two, three, four, or more white flashes, followed by a red one. It should be remarked, that, in this case, as the red color diminishes the luminous intensity, the red lens should have larger dimensions to compensate for this loss; as this causes a loss of light, M. Allard prefers, in most cases, to separate the group of white flashes simply by an obscure interval. This is obtained by a simple modification in the form of the vertical lenses. There are thus the following eight characteristics:

1. White scintillating light.
2. Light with alternate red and white flashes.
3. Light with two white flashes and one red successively.
4. Light with three white flashes and one red successively.
5. Light with four white flashes and one red successively.
6. Light with two white flashes, with intervals of obscurity.
7. Light with three white flashes, with intervals of obscurity.
8. Light with four white flashes, with intervals of obscurity.

These are the only characteristics which have been definitely adopted They have the advantage of being readily recognized without consulting a time-piece.

The Serrin regulator, arranged for alternating currents, has been adopted as the standard lamp. No other apparatus has given better results. Especially with alternating currents, its working is excellent, because the armature of the electro-magnet detaches itself very

easily; and besides, as the consumption of both carbons is uniform, the arc remains absolutely fixed.

The machines for generating the current have been of late years the subject of attentive study, which has been unfortunately confined to three types, the Alliance, Gramme, and De Meritens. The luminous intensities of each of these machines have been measured under carefully-arranged conditions. Photometric measurements in such cases are rather delicate. To make them, since the intensity varies in the vertical direction with different heights, a movable mirror is used, which is placed at different heights in the same vertical plane, and which, in each position, throws the rays on the photometer; and thus the average intensities could be obtained. But, as the intensity of the electric light constantly varies, it was necessary to make the observations at one-minute intervals for each position of the mirror. It is not necessary here to go into the details of construction of the different machines; the table below gives the results obtained.

MACHINES.	Number of revolutions per minute.	Horse-power.		Luminous intensity.	
		Total.	Less power used in transmission.	Total.	Per horse-power.
				Carcels.	
Alliance	450	5.18	4.62	275	59.5
Gramme No. 1	550	12.04	11.48	1,010	88.5
" No. 2	600	6.01	5.45	493	90.0
" No. 3	680	7.06	4.20	342	81.4
De Meritens	790	8.06	7.50	536	84.8

It will be seen that the Alliance machine gives a far less intensity per horse-power than the two others, which are approximately equal. The De Meritens has certain characteristics of stability and solidity which the Gramme machine does not possess; it was, besides, preferred to use alternating currents. For these reasons it has been adopted, and will be installed in all the new light-houses.

The figures giving the intensity in the preceding table refer to the naked light. When this is placed in a fixed-light apparatus, these intensities become in round numbers, 12,000 carcels with the Alliance, and 20,000 carcels with the Gramme No. 2. The flashes increase the intensity still more. In a scintillating light with red and white flashes there is an intensity of 60,000 carcels with the Alliance, and 110,000 carcels with the Gramme machine; with a scintillating light with groups of white flashes, 90,000 carcels for the former, and 150,000

carcels with the latter. The intensities with the De Meritens machine are about the same as with the Gramme; and 125,000 carcels may be taken as the average intensity when the electric light is used.

Some details will now be given of the installations actually existing and of those in process of construction; especially describing the lights of La Hève, the first in date to be electrically lighted, and the Planier light, whose installation has just been completed.

The lights of La Hève, situated on the cape of this name and on the top of the cliff, are, from this fact, very elevated; so the towers themselves are not of great height. Both towers are square, and are placed about sixty metres apart; between them being the long building containing the steam-power, generators, and quarters for the keepers.

There are four Alliance machines, two for each light. The two on the left supply the left-hand tower, and the two on the right the tower on the right-hand. The conductors leading the current from

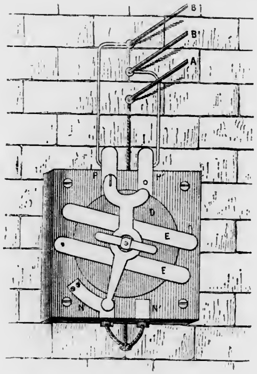

FIG. 2.

the generator are, first, thick copper rods connected with the commutator, Fig. 2. The rod A communicates with the two similar poles of the two machines, the rods B and B′ being connected to the opposite poles. Ordinarily one machine supplies each light. Thus the current arrives by A, and, without traversing the commutator, goes by the cable to the regulator, (or lamp;) thence it returns by the second wire of the same cable to N, follows the vertical conductor to P, and returns to the machine by the rod B. If it is desired to use the machine

corresponding to the rod B′, the central handle is turned, thus bringing the plate D in contact with P′ instead of P, retaining always the contact at N. In this case the current arrives, as before, at A, goes to the regulator, returns again, but passes this time from N to P′, and thence to the machine by B′.

In foul weather, or whenever it is necessary to increase the luminous intensity, both machines are coupled in quantity. The commutator is then turned until the plates E and E′ are in contact—the one with P′ and N′, the other with P and N; the return current flowing simultaneously by B and B′.

The tower of each light is surmounted by a square structure, at one of the angles of which is the optical apparatus. This is clearly shown

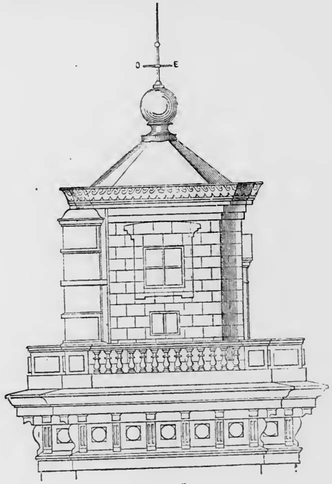

FIG. 3.

in Fig. 3. A kind of glass drum closes the open angle of this structure, which is in two stories, in each of which is a distinct optical apparatus. The intention of this arrangement is to allow one optical apparatus to be instantly replaced by the other, in order to avoid total extinction in case of accident. In each story there are two regulators, which can be substituted for each other by means of the crossed

rails shown in Fig. 4. The cable with three conductors leading from the commutator, previously described, arrives at the lower story. One of the conductors (A) is connected to the metal platform carrying the rails, also metallic; the conductor B connects with the sliding rod of the long bolt M T. When this bolt is lowered, it connects the conductor B with a wire going from the bottom staple of the bolt to a spring contact under the lamp. The latter receives the current, partly by

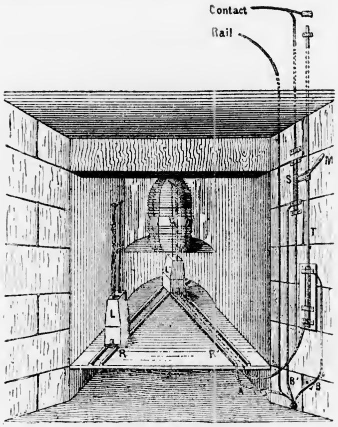

Fig. 4.

the rails, partly by the contact underneath. The wire B communicates with a smaller bolt sliding at the same time with M T, and whose lower staple is connected to the wire coming from the staple of the larger bolt, so that, when the current passes by B', it always traverses the lamp, and, when the two machines are at work together, the two currents are united by the connection between the two staples. The upper staples are connected in the same way to the apparatus in the second story; and, when the bolts are raised, the upper lamp is lighted.

The regulators can thus be changed in two ways, either by drawing the lamp at work back on the rails, and quickly pushing the other one in its place, or by manipulating the commutator bolt, which shifts the luminous arc from one story to the other. Since the establishment of the lights at La Hève, the latter means have been found superfluous, and will no longer be employed.

The light of Planier, which has just been finished, is about eight nautical miles from the port of Marseilles, upon a rock. It is a tower sixty metres high, and eighteen metres in diameter at the base, which rests on the rock itself.

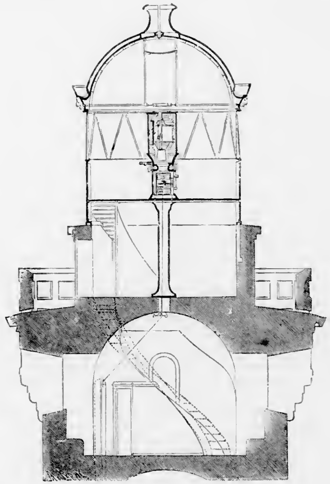

Fig. 5.

Fig. 5 gives the details of the summit of the tower, and Fig. 6 those of the optical apparatus. In the latter figure are shown the fixed-light apparatus, and, movable around it, the drum, with vertical lenses. The mechanism for driving the latter is given in considerable detail.

In this apparatus the changing of the regulators is effected by means of a system of two pairs of rails; but they are not placed at an acute angle, as at La Hève. One enters direct into the optical apparatus; the other is placed outside, and at right angles to the first. At their junction is a turn-table; and, with this arrangement, the manœuvre of changing the lamps takes no longer than with oblique rails.

The De Meritens machines, which feed the regulator, are placed in a special building. The plan and elevation of this building, which will serve as a type for those installed at most of the light-houses, is shown in Fig. 7.

The Planier is a full horizon light. Its characteristic is that of three white flashes separated by a red flash. Its range, like that of all the new lights in the Mediterranean, is twenty-seven nautical miles for fourteen-fifteenths of the year.

We have mentioned that the transformation of the Palmyre light is also in progress. This, unlike the Planier, will throw a beam in one direction only; and the arrangement of the lantern is therefore slightly different. It is shown in Fig. 8. The general disposition resembles, up to a certain point, that of La Hève. The optical apparatus for the new fixed lights will have a diameter of 0.6 met., instead of 0.3, as was formerly employed. With the revolving cylinder of vertical lenses, this diameter will reach 0.7 met.

As the electric installation at the Planier light-house is the newest and most complete, some further details of its arrangement will be of interest. The plan (Fig. 7) shows clearly the position of the two generators and of the transmission-shafting which sets them in motion.

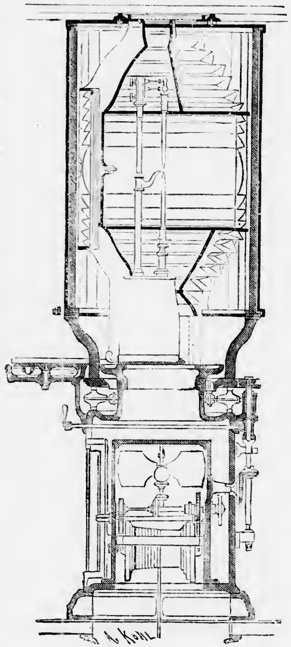

Fig. 6

Both generators are placed upon the same masonry foundation, and their axes are in the same line. In order, however, that one may be ready to replace the other in case of accident, their shafts are keyed together, and they both turn, the one with an open, the other with a closed circuit. Between the two machines is a short column (shown in Figs. 9 and 10) which supports the guides for changing the belts from the loose to the fixed pulleys.

Each machine is divided into two circuits, shown by four terminals placed at the upper part of the frame, two at each end. The two terminals placed beside each other at each end of the machine are those

which at a given instant form poles of the same name. From each of them is led a copper conductor to the foot of the machine; thence, along the masonry foundation, it follows along the ground, (as shown in Figs 9 and 10,) and arrives at a commutator placed on the masonry

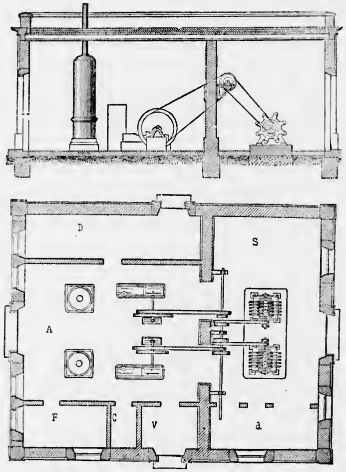

Fig. 7.

A.—Engine and boiler house. S.—Electric generator room. F.—Forge and heavy repair-shop. *d.*—Shop for light repairs. D.—Coal depot, with water-tank underneath. *c.*—Water-tank. V.—Vestibule.

column, which forms one support of the shafting. One object of the commutator is to take the current at will from either machine; another is to couple, either in tension or quantity, the two circuits of each machine. The four possible combinations of the commutator are shown in Fig. 11. An examination of this figure shows that the apparatus consists of fixed and movable contacts arranged in a circle. The first are fourteen in number. The four on the left are in relation with the terminals 1, 2, 3, 4, from which are led the conductors of the machine on the left, or machine No. 1. The four on the right are connected with the terminals corresponding with the conductors of machine No. 2. The three upper contact pieces are attached to the terminals communicating with the conductors of the lamp.

It should be said that the current reaches the lamp by a large cable, then, after traversing the arc, is divided between two smaller cables,

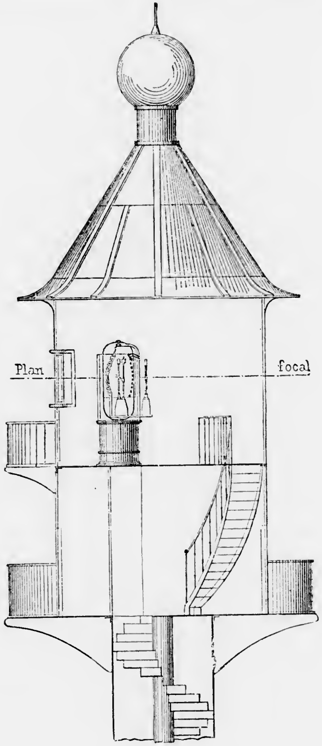

FIG. 8.

n one of which is placed the electro-magnet of the lamp. Of the hree upper contacts, that of the left communicates with the terminal E, to which is connected the cable of the electro-magnet just mentioned; the next belongs to the terminal P C, of the second small able; finally, the right contact, twice as large as the others, is in

communication with terminal G C, of the large cable. This system of fixed contacts is completed below by three pieces, the centre one

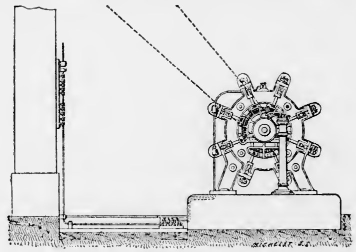

FIG. 9.

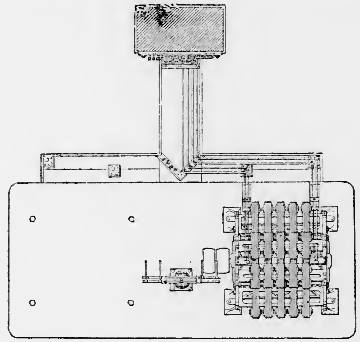

FIG. 10.

having double the length of the others. The side pieces communicate by means of auxiliary conductors—that on the left with the contact piece of the terminal E, that on the right with the contact piece of the terminal G C.

The movable contacts to the number of eight are shown in the figure. They are all carried on one plate, free to move around the centre of the apparatus. The two innermost contacts are connected together so as to form a sort of **U**; the next pair forms a larger **U**; and the four others are connected, two and two, by circular strips. The different pairs of contacts are, of course, insulated from each

other. A handle in the centre of the movable plate serves to place it in different positions.

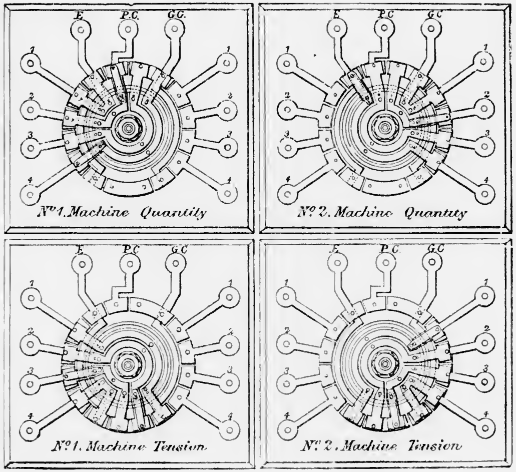

Fig. 11.

Suppose, for example, that the movable contacts are in the first position shown in the figure for quantity. The terminals 1 and 2 being at the same instant, poles of the same name, the current enters simultaneously by the two movable contacts corresponding to these terminals, and passes at the same time into the small cable and the cable in which is the electro-magnet. After passing the carbons, it is reunited in one conductor, and returns by the large cable to the terminal G C. On the fixed contact of double size, in connection with this terminal, rest the two movable contacts by which the current returns to the terminals 3 and 4.

In coupling for tension in the same machine, the current, leaving the first circuit of the machine by the terminal 1, traverses the most open pair of movable contacts, and arrives at one of the lower fixed contacts by means of the conductor auxiliary to the contact G C. It then follows the large cable, passes through the carbons, and only traverses the small cable of the electro-magnet to arrive at the terminal E; thence, by the second auxiliary conductor, to the smallest

pair of movable contacts and terminal 4. It then traverses the second circuit of the machine, and returns to the terminal 3. Afterwards, by the second pair of movable contacts, it arrives at the large, lower, fixed contact, from which it is conducted by the third pair of movable contacts to the terminal 2; that is to say, to the first circuit of the machine.

In examining the positions of the movable contacts shown for coupling machine No. 2 for tension or quantity, it will be seen that the direction of the currents is similar.

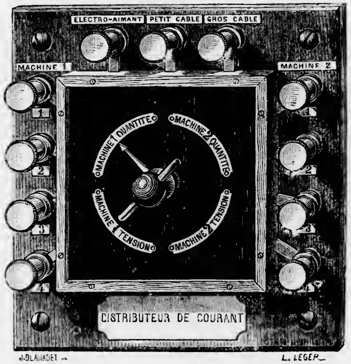

Fig. 12.

Fig. 12 gives a perspective view of this commutator. The contacts are covered with an ebonite plate, through which passes the handle for manipulating the movable plate. This ebonite plate bears four inscriptions, corresponding to the different combinations of the commutator; and an index moving with the handle indicates the combination in use.

The system has the advantage of changing instantly the grouping of the two circuits of the same machine, and of quickly substituting one machine for the other. It has, however, the drawback, common to all turning-contacts, of not being absolutely reliable.

In the English light-houses, for which the De Meritens machine has also been adopted, another style of commutator is used, as shown in Fig. 13. In this arrangement, the terminals to which the conductors from the lamp and those from the two machines are connected have practically the same relative positions as in the previous case. From

these terminals pass stout copper strips, which can be clamped by binding-screws bearing the same numbers as the terminals. The locking-pieces in connection with the terminals of the machine can be connected by thick copper strips by the binding-screws corre-

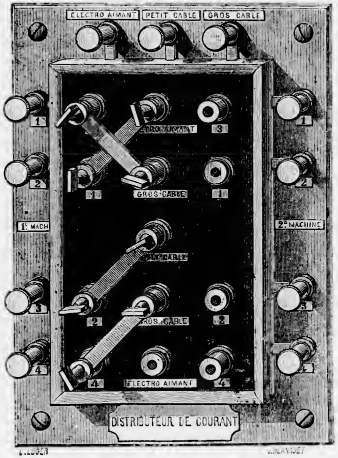

Fig. 13.

sponding to the lamp-cables; and to facilitate this coupling, the locking-pieces are more or less raised, so that the strips may cross each other without touching. In this way perfect contacts are obtained; but a longer time is required to change the combinations. Fig. 13 shows the connections when machine No. 2 is coupled for quantity. Fig. 14 allows the difference in height of the locking-pieces to be seen, and shows how machine No. 1 is coupled for quantity.

The metallic rails upon which the regulator rests have already been described. These rails are in direct communication with the large cable; and it is by them that the current arrives at the frame of the regulator, and thence reaches the carbons. The cable of the electro' magnet and the small cable are attached to two terminals (H and H, Fig. 15) with insulated springs. These springs, pressing on two contacts under the lamp, make the appropriate connections.

The regulator itself is a combination of the Serrin and Berjot lamps. It comprises the two electro-magnets of the latter lamp, the

armatures of which form an internal core, one magnet having coarse wire, and placed direct in the circuit; the other having fine wire, and mounted in a derived current. The former acts on the articulated frame carrying the lower carbon; the latter acts on the disk brake controlling the clock-work.

Fig. 15 shows at S the electro-magnet with coarse wire acting by the arm Q on the frame. R and R′ are the springs which tend to raise this frame. L is the lever which serves to regulate the tension of the spring R; it is controlled by a screw, V, which can be turned by inserting a key at the hole O. The magnet with fine wire is placed symmetrically with the other on the opposite side of the clock-work.

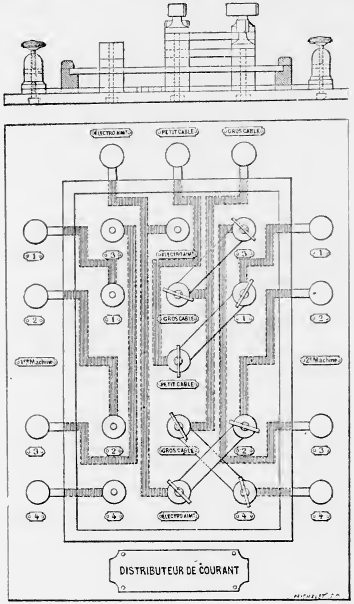

Fig. 14.

The connection of the two carbons to the prime mover of the clock is made by means of a steel ribbon, F, attached to the lower ends of the two rods g and l. This ribbon is led over several pulleys, and is

wound on a wheel on the axis of the prime mover for a great part of its circumference. The turning of this wheel is thus produced in a

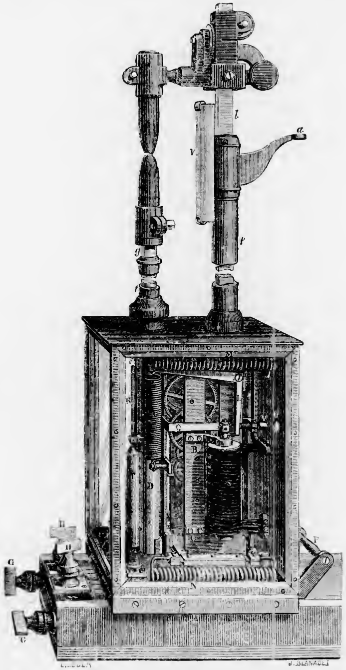

Fig. 15.

very certain manner. The rod g slides in the tube D fastened to the movable frame, and this tube is slit vertically to allow the attachment of the ribbon to pass. This manner of connecting the two carbons, which replaces the chain used by Serrin, and does away with the use of ratchet-wheels, allows the carbons to be placed at any desired height by a slight sliding of the ribbon.

Another peculiarity of this lamp is the mode of connecting the different interior parts of the apparatus. The current of the large

cable arrives at the upper carbons by the rails and uninsulated portions of the regulator. From the lower carbon it returns to the two insulated terminals H and H′, passing to one by the movable frame, and to the other through the electro-magnet S. The connections between the contacts are made with four thick spirals of nickel-plated copper. Two are shown at M and N.

The tube D, which carries the rod g, is not insulated from the frame; but the latter is insulated from the upright which supports it. This is on account of ease of construction, it being less difficult to insulate a straight piece than a round tube like D. An air-pump, T, serves to check the motions of the frame, and to prevent too rapid oscillations. The porous plate V is placed opposite the ends of the carbons, to protect the rods t and l from the excessive heat of the *foyer*. It is composed of the same material as the porous vases used in batteries. When the upper carbon rod arrives at the end of its course, it acts on a bevelled piece, which frees a contact-spring, and suppresses the communication with the fine wire magnet, so that it may not be injured by the passage of too strong a current.

It only remains now to describe the De Meritens machine to complete the description of the electric appliances for light-houses.

M. De Meritens has devised several types of machines. The one adapted for light-house purposes, shown in Fig 16, has the permanent

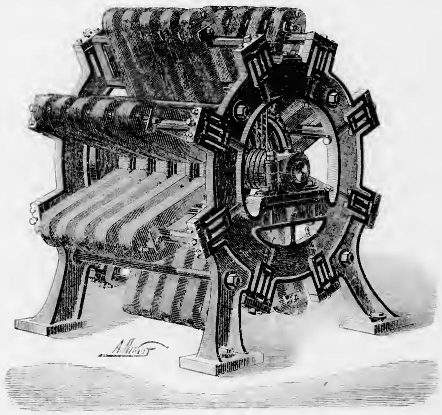

Fig. 16.

magnets of horseshoe form arranged radially around the axis in a precisely similar manner to the disposition of the field-magnets of the old Alliance machine, which in general appearance it at first sight much resembles.

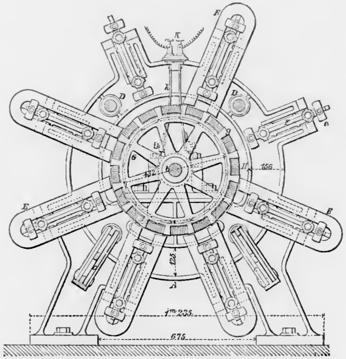

Fig. 17.

Fig. 17 is a transverse section of the machine, and Fig. 18 a longitudinal section taken through the axis, so as to show, in both views, the armature-ring, and the position of the field-magnets with respect to it.

Figs. 19, 20, and 21 show the details of the armature-bobbins, marked H, the iron core-pieces, *h h*, and the projecting pole-pieces, which form enlarged ends to the latter, and are marked *g*. In Fig. 19, which represents a section through half the ring, the method of attachment and of coupling up is clearly shown. On reference to Fig. 17, it will be seen that each armature-ring, G, is built up of sixteen flattened oval bobbins, H, separated from one another by the projecting pole-pieces, *g;* and around each ring are fixed, radially to the frame of the machine, eight very powerfully compound permanent magnets, each composed of eight laminæ of steel. The distance apart of the two limbs of each magnet, as well as the distance between the north pole of one magnet and the south pole of the next, is precisely equal to the distance apart, or pitch around the armature, of the pole-pieces and the coils. The details of the magnets, and their method of adjustment and attachment, are shown in Figs. 22 and 23. Each magnet is built up of eight laminæ of steel, each ten mm. in thickness, and held

together tightly by the bolts and nuts, *c d*, the whole being attached to the brass frames, F, which are fixed to the framing of the machine

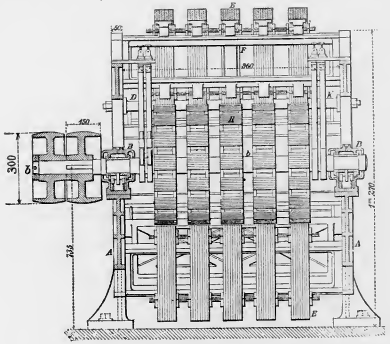

Fig. 18.

in radial slides, by which the distance from the armature-ring can be adjusted with great accuracy. The total weight of the forty magnets (see Fig. 16) is about one ton.

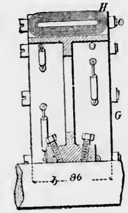

Fig. 19.

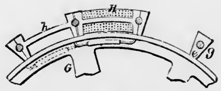

Fig. 20.

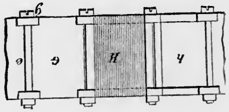

Fig. 21.

The currents from the five armatures are brought together in two groups, to the four brass collecting-disks, *i*, which are mounted in pairs on an insulated bush, *j*, fixed to the principal shaft of the machine. The details of the collecting apparatus are shown in Figs. 24, 25, and 26. Against the disks *i* are pressed, by means of springs, the four collecting plates or brushes, K′ K′, which are in metallic connection with the attachment screws K K, of which there are two pairs, one at each end of the machine, (as shown in Fig. 18.)

The construction of the armature is very interesting and ingenious. Each of the induction-coils shown at H (Figs. 19, 20, and 21) is composed, first, of a flat spool or bobbin of the form marked h, and then is wound in a lathe with insulated copper wire 1.9 mm. in diameter, and of which the total weight in the whole machine is from 120 to 130 pounds. The iron cores of these coils are built up of eighty thicknesses of soft sheet-iron one millimetre in thickness, and stamped out

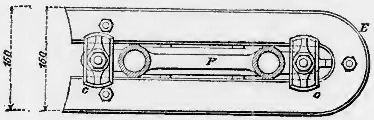

Fig. 22.

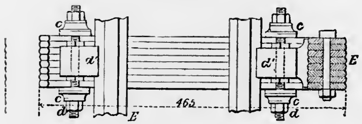

Fig. 23.

by a machine. The coils are wound, and attached to the armature-wheel by a set of bolts, marked e, which pass through the projecting lugs g of the wheel, and through the cylindrical hole formed by the semi-cylindrical grooves in the ends of the iron core-pieces when abutting the one against the other.

The coupling-up of the armature coils is one of the most ingenious features of the machine; for, as the magnets are arranged around the armature in such a way that in the rotation of the coils alternate

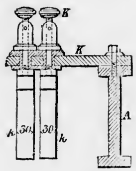

Fig. 24.

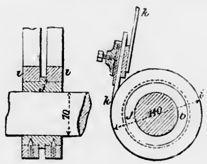

Fig. 25.

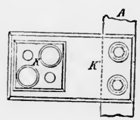

Fig. 26.

poles are presented to any one bobbin, it follows that if the bobbins were numbered 1, 2, 3, 4, &c., up to 16, the currents induced in all the even-numbered bobbins would be in one direction, and in all the odd numbers in the opposite; and it would appear at first sight that

these coils could not be connected together in series without the one set of currents neutralizing the other. But, by connecting the armature-coils together in the manner shown in Fig. 27, it will be seen that although the currents generated in consecutive coils are opposite in direction to one another, yet their combined current transmitted to the collecting apparatus is in the same direction.

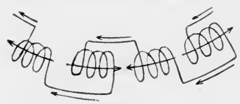

Fig. 27.

In the early part of this article attention was drawn to the distinction between the luminous and geographical ranges; and in all the installations described, regard has only been paid to the increase of the former, the latter being neglected. This is readily explained by the necessity there was of giving a unit to the new system of lighting the French coasts. There is, however, a point which it will be important to consider, and which may serve to augment the efficiency of the system. In days of heavy fog, when the luminous range is considerably diminished, this diminution would be much less if the geographical range could be increased.

A rather important step has been made in this direction by the use of specially-constructed optical apparatus. This apparatus is furnished on the upper part with a series of annular lenses, whose effect is to project above the light a beam of vertical rays extending to a great height. This beam illumines either the clouds, or the vapor which fills the atmosphere, and is even visible in clear weather, because the air contains enough particles, both solid and vaporous, to allow the phenomenon of diffusion to be produced. These luminous rays thus projected are visible to quite a distance even in foggy nights, and the geographical range is notably increased.

The first application of this system, which has not yet been adopted in France, is about to be made in the Sea of Azof. The ships which cross this sea in the direction of Berdiansk are guided to their point of arrival by a light, which, in the actual state of its installation, could not be seen sufficiently far; and it was decided to apply the system mentioned above. The apparatus recently constructed by Messrs. Sautter and Lemonnier will shortly be installed, and then the efficacy of the system can be judged.

The example thus given by the French light-house board has already been followed by other nations. The Ottoman government has studied a plan of electric lighting for the coasts of Turkey. In England an appropriation has been asked to establish, in 1881, about sixty electric

lights; and a similar request will be made for the establishment of a hundred lights in 1882.

On account of the time which the complete execution of the project for lighting the French coasts will take, it may be that the experience obtained with the first lights will show some modifications to be made in the adopted plan, and that the lights last made may not have entirely the same dimensions and characteristics as those first built.

In fact, some criticisms have been made by foreign engineers, especially on the diameter of 0.6 met. of the optical apparatus, a diameter which these engineers consider relatively too small. The faults ascribed to optical apparatus of small diameter are those of heating too readily on account of the proximity of the luminous *foyer*, and also that of being more quickly covered with carbon-dust. We do not, however, believe that there is much to fear from this with apparatus 0.6 met. in diameter, since for the last twenty years the lights of La Heve have worked well with apparatus 0.3 met. in diameter. The probabilities are that future modifications will only be changes in detail, which will not affect the general project.

The above shows the means France has taken to light her coasts, and is a most emphatic recognition of the value of the electric light for that purpose.

The arc light, however, has two defects which have not been mentioned—one, a lack of fixity; the other, a deficiency in the red and yellow rays of the spectrum. This lack of fixity is partly due to the carbons not being homogeneous, and partly to faults in the regulators. Improved processes of manufacture have in a great measure removed these defects, but even the best lights will still occasionally flicker.

The red and yellow rays have the greatest penetrating power; and for this reason an oil light, which is rich in these rays, can be seen farther in foggy weather than an electric light of *equal candle-power*. But the electric light can be made so much more powerful than the best oil light that this deficiency can be more than made up; still, it must be borne in mind when the candle-powers of the two lights are compared.

When the French system was adopted, the incandescent electric light had not left the domain of experiment; and even now its luminous intensity is very much less than that which can readily be obtained from an arc light of moderate dimensions. It possesses, however, the element of remarkable fixity, and is rich in red and yellow rays. No light could be better for a light-house, if it can be produced cheaply, have sufficient luminous intensity, and be made reliable. It will,

moreover, dispense with the somewhat complicated and expensive regulators.

It is in this line that the Light-House Board of the United States is about to make experiments, and the results obtained will have great interest for the whole world.

Since writing the above the Light-House Board has contracted for an iron skeleton tower two hundred and fifty feet high, carrying six powerful arc lights, to be erected at Hallet's Point, New York, by November 1, 1883, for the purpose of illuminating the passage through Hell Gate.

This will be the first application in the United States, by the Government, of the electric light as an aid to navigation, and will not be a light-house in the ordinary sense of the term, but is intended to light the channel in the same way as electric-light towers light the streets of various cities, notably in Cleveland, Ohio, and at Madison Square, New York, where the Brush Company has erected towers two hundred and fifty feet high for this purpose.

The Light-House Board has also ordered the necessary lenses and electrical appliances for the purpose of testing the value of both the arc and incandescent lights, for light-house purposes. The experiments will be made at the light-house depot, Staten Island, under the immediate charge of the district officers.

The greater part of the above appeared in "Science."

DAVID PORTER HEAP.

END OF
TITLE